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A COMPARISON OF PROSTATE CANCER INCIDENCE BETWEEN U.S. AIR FORCE ENLISTED AIRCREW AND NONAIRCREW

Joseph A. Lopez, MD, MPH
Col, USAF, MC

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Air Force Research Laboratory
711th Human Performance Wing
School of Aerospace Medicine
Aerospace Medicine Education
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

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Several studies have shown elevated prostate cancer risk in civilian and military aviators and aircrew, while other studies have demonstrated no increased risk. The majority of these investigations compared aviators/aircrew to the general population. The objective of this study was to determine prostate cancer risk among enlisted aircrew in the United States Air Force (USAF) utilizing comparable cohorts of aircrew and nonaircrew. This retrospective analysis identified cases of prostate cancer from the Automated Cancer Tumor Registry of the Department of Defense cross-referenced with official USAF personnel records to identify enlisted aircrew and nonaircrew. A nested case-control analysis was performed to determine prostate cancer risk; this analysis showed no difference between the two groups. No difference was noted when rank/grade, race, and Air Force career group were taken into account. The findings of this study suggest that USAF enlisted aviators did not carry an excess risk of prostate cancer during the study period when measured against a comparable reference group of enlisted airmen.

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TABLE OF CONTENTS

LIST OF TABLES

1.0 SUMMARY

Several studies have shown elevated prostate cancer risk in civilian and military aviators and aircrew, while other studies have demonstrated no increased risk. The majority of these investigations compared aviators/aircrew to the general population. The objective of this study was to determine prostate cancer risk among enlisted aircrew in the United States Air Force (USAF) utilizing comparable cohorts of aircrew and nonaircrew. This retrospective analysis identified cases of prostate cancer from the Automated Cancer Tumor Registry of the Department of Defense cross-referenced with official USAF personnel records to identify enlisted aircrew and nonaircrew. A nested case-control analysis was performed to determine prostate cancer risk; this analysis showed no difference between the two groups. No difference was noted when rank/grade, race, and Air Force career group were taken into account. The findings of this study suggest that USAF enlisted aviators did not carry an excess risk of prostate cancer during the study period when measured against a comparable reference group of enlisted airmen.

2.0 INTRODUCTION

Prostate cancer is the third most common cause of cancer death in men of all ages, and it is the most common cause of death from cancer in men over age 75 (Ref 1). An estimated 217,730 men were diagnosed with prostate cancer in 2010, of which 32,050 were expected to die of their prostate cancer (Ref 2). Prostate cancer is infrequently found in men younger than age 40. Risk factors most associated with the development of prostate cancer include African-American descent, men older than 60 years of age, and a family history of prostate cancer in a first-degree relative. Other risk factors include alcohol abuse and a high animal fat diet. In addition, occupational and environmental factors such as being a farmer, tire plant worker, painter, or cadmium worker and agent orange exposure have been associated with an increased risk of developing prostate cancer (Ref 1,3).

Similarly, an increased cancer risk, including prostate cancer, has been cited as a possible consequence of flight, based on several retrospective studies that examined possible adverse occupational health effects among civilian and military aviators and aircrew (Ref 4-12). Factors such as increased exposure to galactic cosmic radiation from flying at high altitudes have been proposed as a possible contributor to the development of cancers of various types, including prostate cancer (Ref 9,13). However, other studies of cancer incidence in large populations living chronically at elevated terrestrial altitudes with high natural background radiation have failed to demonstrate an increased cancer incidence (Ref 14,15).

While some studies of aviators have shown an increased incidence of prostate cancer, others have not. For example, one long-term cohort study of Air Canada pilots completed in 1996 found a decreased incidence of some cancers but an increased incidence of others, including prostate cancer, with an elevated standardized incidence ratio (SIR) for prostate cancer of 1.87 (95% confidence interval (CI): 1.38-2.49) (Ref 16). Another study, of U.S. commercial pilots, found an increase in mortality from prostate cancer, with a mortality odds ratio (OR) of 1.46 (95% CI: 1.06-2.03) (Ref 10). Pukkala et al. studied pilots from Denmark, Finland, Iceland, Norway, and Sweden; they reported an excess prostate cancer risk of 1.21 (95% CI: 0.93-1.54). Although the confidence interval crossed unity, when the authors divided the cohort into pilots with >10,000 flying hours and those with <5,000 flying hours, an increased relative risk (RR) of

3.38 (95% CI: 1.26-11.9) for prostate cancer was revealed (Ref 11). On the other hand, a study of 3,877 Danish commercial aviators found no increased incidence of prostate cancer (SIR=0.8) (Ref 7). In addition to their retrospective design, these studies were limited by their reliance on death certificates and medical records. Furthermore, they used a general civilian population as a reference group, which may not reflect such potential confounding factors as differences in socioeconomic status or the availability of medical care, as discussed later in this report. Two studies attempted to estimate the incidence of various cancers among U.S. military members by comparing their cancer data with that of the U.S. general population. Among their results were finding SIRs for several cancers, including prostate cancer, in excess of that in the general population (Ref 17,18). Another study on all-cancer risk for the decade prior to 1990 compared USAF military officer aircrew vs. officer nonaircrew in an attempt to achieve a more comparable reference group. Among the results was an increased RR for urinary cancers of 2.33 (95% CI: 1.27-4.27) among aircrew, although the risk for prostate cancer was not specifically sought (Ref 6). A case series reporting a cluster of prostate cancer cases among four USAF fighter aircrew from the same military community in 2008 prompted further analysis of prostate cancer cases within the USAF Aeromedical Information Management Waiver Tracking System database. The findings suggested a 2.4-fold increase in prostate cancer risk for fighter aircrew vs. transport or bomber aircrew (Ref 19). A more recent study demonstrated a three-fold increase in prostate cancer among all USAF servicemen since 1990 when compared with the expected risk in the U.S. population (Ref 20). On the other hand, another study utilizing the same Department of Defense (DoD) data base, focusing specifically on prostate cancer risk in USAF officer aviators vs. officer nonaviators during the time period from 1987 to 2008, revealed no increase in prostate cancer among officer aviators (Rogers D. Personal communication, 2010).

In summary, there have been inconsistent results regarding the risk of prostate cancer among aviators and aircrew in both civilian and military study groups. Furthermore, an unanswered question remains as to whether military service in the USAF, and aviation duties among enlisted aircrew in particular, is associated with an increased risk of prostate cancer. It is with this question in mind that this study was undertaken. My null hypothesis was that enlisted USAF aviators would not have an increased risk of prostate cancer vs. enlisted nonaviators during the study period, 1987 to 2008.

3.0 METHODS

3.1 Data Collection

After Institutional Review Board approval was obtained from the USAF 711th Human Performance Wing, the Armed Forces Institute of Pathology, MD Anderson Cancer Center, and the University of Texas Health Science Center, personnel data for enlisted active duty USAF males serving between January 1, 1987, and December 31, 2008, were obtained from the U.S. Air Force Personnel Center (AFPC). Individuals diagnosed with prostate cancer were then identified in the DoD Automated Cancer Tumor Registry (ACTUR). ACTUR is the designated repository for the uniformed services medical treatment facilities (MTFs) to compile, track, and report cancer data on DoD beneficiaries. In the case of prostate cancer, records are entered into ACTUR based on documented biopsy results. ACTUR was queried for all prostate cancer cases diagnosed in USAF enlisted members between the years 1987 and 2008. Data obtained from ACTUR were then cross-referenced with the personnel data from AFPC, including rank, date of

entry into active duty, Air Force Specialty Code (AFSC)/career group, and date of separation or retirement from active duty. For purposes of this study, enlisted Air Force aviators were defined as those whose usual job duties entailed regular flying on military aircraft. Enlisted Air Force aviator AFSCs include the following career fields: In-Flight Refueling, Flight Engineer, Aircraft Loadmaster, Airborne Communication and Electrical Systems, Airborne Battle Management, Airborne Missions Systems, Flight Attendant, Aerial Gunner, and Airborne Cryptologic Linguist. These career fields comprise a substantial proportion of the Operations career group. Other USAF career groups include Logistics, Support, Medical, Professional, Acquisitions, Special Investigations, Special Duty, and Reporting Identifiers/Transitive Status.

3.2 Statistical Analysis

Due to the small number of enlisted Air Force aviators found to have prostate cancer (two cases) during the study period, a nested case-control analysis was conducted to better understand the significance of these cases. Cancer-free controls (four-fold controls vs. cases) were randomly selected from among the enlisted active duty Air Force population during the study period. ORs for having prostate cancer were then calculated for enlisted aviators vs. enlisted nonaviators. In addition, ORs were calculated comparing prostate cancer cases from the Operations career group with cases in the other enlisted USAF career groups. ORs were also done to compare the enlisted aviators with prostate cancer to other enlisted Air Force members with prostate cancer based on grade/rank, as well as on race/ethnicity (black vs. white).

Statistical analysis was performed using SAS 9.1 (SAS Institute, Inc., Cary, NC).

4.0 RESULTS

For the study period 1987 to 2008, 328,752 USAF male active duty enlisted records were identified. When ACTUR was queried, 86 of these members were determined to have been diagnosed with prostate cancer during the study period. Of these cases, 2 were enlisted aviators and 84 were enlisted nonaviators. The average age at diagnosis for all cases (n=86) was 45.3 yr. The ages of the two enlisted aviators were 47 and 49 yr (average=48 yr). Among nonaviators (n=84), the average age at diagnosis was 45.2 yr. At the time of diagnosis, 55 of the 86 (64%) cases were on active duty. None of them died while on active duty. The enlisted aviators diagnosed with prostate cancer were from two career fields: one was an Aerial Gunner (age 49 years) and one was a Flight Engineer (age 47 years). Flight hours for these aviators were not available, but career flying hours for these AFSCs have averaged 5,500 to 6,500 h (Doncaster LB. Personal communication, 11 Jun 2011).

Table 1 shows the results of the nested case-control analysis of prostate cancer in enlisted aviators vs. nonaviators. The OR of an enlisted aviator having prostate cancer vs. an enlisted nonaviator was 0.795 (95% CI: 0.171-3.698). However, since the CI crossed unity, the finding was not statistically significant. All the aviators with prostate cancer in this study were African American; consequently, we were not able to stratify by race. However, given the small number of prostate cancer cases among enlisted aviators and the absence of cases in nonblacks, an additional statistical analysis was performed to determine if our enlisted prostate cancer cases were more likely to be African-American. A “continuity correction” was performed, a standard statistical procedure utilized when there is a scarcity of data or a zero cell. This requires the addition of 0.5 to each cell of the 2 X 2 table, including the zero cell, which allows for a

calculation giving a close approximation of the OR. In this case, the OR was 3.43 (95% CI: 0.36-6.50), as shown in Table 2. Therefore, among those enlisted males diagnosed with prostate cancer, aviators were three times more likely to be black. However, since the CI crossed 1.0, it was not a statistically significant finding; therefore, the fact that all the enlisted aviators diagnosed with prostate cancer were black could have been due purely to chance. Nevertheless, it was possible to determine the OR for having prostate cancer among black (vs nonblack) enlisted members with prostate cancer, as shown in Table 3, and the result was consistent with the published literature: 5.7616 (95% CI: 3.3775-9.8287) (Ref 2).

Table 1. Enlisted Aviator by Cancer[a]

Aviator	Cancer		Total
	Yes	No	
Yes	2	10	12
No	84	334	418
Total	86	344	430

[a]OR = 0.795 (95% CI: 0.171-3.698)

Table 2. Aviator by Race[a]

Aviator	Black	
	Yes	No
Without Continuity Correction		
Yes	2	0
No	44	30
With Continuity Correction		
Yes	2.5	0.5
No	44.5	30.5

[a]Frequency missing = 10

Table 3. Enlisted Aviator Cancer by Race[a]

Black	Cancer		Total
	Yes	No	
Yes	46	66	112
No	30	248	278
Total	76	314	390

[a]Frequency missing = 10
OR = 5.76 (95% CI: 3.38-9.82)

Table 4 shows the breakdown of enlisted members diagnosed with prostate cancer by military rank. The two enlisted aviators with prostate cancer were senior noncommissioned officers (SNCOs). Comparing them with NCOs diagnosed with prostate cancer was useful from the standpoint of establishing whether being a SNCO aviator, with presumably more cumulative exposure to the flight environment, was a potential risk factor for the development of prostate cancer among enlisted aviators. The OR from this analysis was 1.39 (95% CI: -1.69-4.47). Thus, the risk of having prostate cancer as a SNCO was 40% greater than that of NCOs having prostate cancer. However, since the CI included 1.0, the finding was not statistically significant. Additional analyses were performed to compare the prostate cancer risk between the Operations enlisted career group, which includes enlisted aviators, and the other USAF enlisted career groups; these results are summarized in Table 5. The CI for all the ORs crossed unity, suggesting there was no difference in prostate cancer risk between the Operations enlisted career group and other USAF enlisted career groups.

Table 4. Enlisted Cancer by Rank and Aviator Status[a]

Rank[b]	Aviator		Total
	Yes	No	
NCO			
SSgt	0	4	4
TSgt	0	14	14
Total without Continuity Correction	0	18	18
Total with Continuity Correction	0.5	18.5	18
SNCO			
MSgt	2	41	43
SMSgt	0	10	10
CMSgt	0	15	15
Total without Continuity Correction	2	66	68
Total with Continuity Correction	2.5	66.5	68
Total by Rank	2	84	86

[a]OR = 1.39 (95% CI: -1.69-4.47)
[b]SSgt = staff sergeant
TSgt = technical sergeant
MSgt = master sergeant
SMSgt = senior master sergeant
CMSgt = chief master sergeant

5.0 DISCUSSION

The principal finding of this study of no difference in prostate cancer risk between USAF enlisted aviators and enlisted nonaviators was ascertained after data extraction from official USAF personnel records for determination of occupation and cross-referencing with a DoD-wide cancer database for cases of prostate cancer. There are several possible explanations for the difference between our finding and those of other studies on aviators/aircrew. One reason has to

do with the number of flying hours logged by military aviators vs. their civilian counterparts. Military missions tend to be shorter and are flown at lower altitudes, for the most part, in contrast with civilian aviators/aircrew, many of whom fly long-haul routes at higher altitudes. Similarly, a significant number of these long-haul flights carry aircrew over polar routes, where they are exposed to higher levels of cosmic radiation (Ref 13). The study by Pukkala confirmed an increased RR for prostate cancer among long-haul civilian pilots (Ref 11).

Table 5. Relative Risk for USAF Enlisted Career Groups vs. Operations Career Group

Other Career Group	OR	95% CI
Maintenance/Logistics	0.8542	0.3815-1.9126
Support	0.5639	0.2498-1.2727
Medical	0.3214	0.1008-1.0251
Professional	0.0362	-3.0708-3.1503
Acquisitions	0.2596	0.0379-1.7780
Special Investigations	0.9048	-2.2093-4.0188
Special Duty	0.4760	0.1239-1.8277
Reporting Identifiers	3.0762	0.1414-6.0109

Another important explanation for the difference in results seen between this study and previous studies on cancer in aviators/aircrew could stem from the fact that other studies often compared cancer rates in aviators with cancer rates in the general population. This practice could well introduce several confounding factors, since it could be argued that these two populations differed in several important aspects, including socio-economic status and access to healthcare. For example, aviators (both civilian and military) must undergo frequent and more rigorous medical examinations than the general population. Grayson and Lyons confirmed greater age-adjusted cancer incidence rates when military officer aviators were compared with general population data than when they were matched with an internal reference group of nonaviator officers (Ref 6). The current study also used an internal control group, of enlisted peers of similar socio-economic status, fitness, and access to healthcare, of which the standards of compliance of the latter two are mandated to a significant degree within the military. In addition, it is notable that our prostate cancer study group was a much younger population at diagnosis (just over 45 yr old) than what has been found in other studies among cases in the general population. This is consistent with the fact that the average enlisted military member's nondisability retirement age during the study period was approximately 43 yr, representing an average of 22 yr of military service (Ref 21). In contrast, among the U.S. general population, the median age at diagnosis for prostate cancer is 67 yr (Ref 2). Similarly, many retired military members of this age range would not receive their medical care at MTFs but from civilian medical providers; thus, prostate cancer cases occurring in this population would most likely not be captured in ACTUR. It may well be that if we were able to track enlisted members beyond their active duty service time into retirement, a difference in prostate cancer risk between former enlisted aviators and nonaviators might become evident.

6.0 CONCLUSION

The findings of this study suggest that USAF enlisted aviators did not carry an excess risk of prostate cancer during the study period when measured against a comparable reference group of enlisted airmen.

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LIST OF ABBREVIATIONS AND ACRONYMS

AFPC	Air Force Personnel Center
AFSC	Air Force Specialty Code
CI	confidence interval
DoD	Department of Defense
MTF	medical treatment facility
NCO	noncommissioned officer
OR	odds ratio
RR	relative risk
SIR	standardized incidence ratio
SNCO	senior noncommissioned officer
USAF	United States Air Force